and not bewilderingly complicated like those of tropical America. Africa, too, is especially rich in naturalists who are waiting to be inspired and encouraged, as they will assuredly be by the present work. The author is to be congratulated upon the fine volume and the beautiful plates which are the outcome of his labour of love. It cannot be long before he may be congratulated upon their fruitful results. E. B. P.

THE GEOLOGY OF EGYPT.

Geological Map of Egypt. Scale 1 : 1,000,000 (six sheets) and reduction of the same to the scale 1 : 2,000,000. (Cairo : Survey Department, 1910.)

SOON after the occupation of Egypt by a British military force in 1882, the late Prof. Huxley, then president of the Royal Society, directed attention to the valuable opportunity that was afforded for the extension of our geological knowledge in that interesting country. He instanced the valuable series of scientific memoirs that had been prepared by French savants during the occupation of the country at the beginning of the nineteenth century, as an example worthy to be followed. Following his advice, the Royal Society appointed a "Delta Committee" to arrange for explorations, which it seemed desirable to undertake, and made various grants from its funds to defray expenses. The War Department of the Government, on being applied to by the Royal Society, agreed to lend the service of some of the engineer-officers, then in the country, to supervise the work.

As the result of these arrangements, borings were put down at a number of points in the Nile Delta, and reports on the materials sent home were submitted to the society by the Delta Committee in 1885 and 1897, and were published in the Royal Society Proceedings.

But in 1893–4 an engineer-officer, Captain H. G. Lyons, already known in this country by his geological work in the Bagshot area, was employed on patrol work in the oases of Kharga and Dakhla and in the desert routes to the south of them, and he took the opportunity thus afforded to him for making a number of geological observations in the district, which proved to be of great value and interest. Two years later the Egyptian Government decided to establish a geological survey of the country, and to place it under the direction of Captain Lyons. A staff of surveyors was formed, consisting of four young geologists from the Royal College of Science—Messrs. Barron, Beadnell, Hume, and Ball—and for a time Dr. Blankenhorn acted as palæontologist to the survey. The first named of these surveyors, after doing much excellent work, fell a victim to the climate of the Sudan in 1906. A number of very valuable memoirs by Captain Lyons and his staff have been published, some of which have been already reviewed in the pages of NATURE.

As Egypt and the Sudan have no good topographical maps to be placed at the disposal of the geological staff, topographers have had to be attached to each of the geological surveying parties; in this branch of the work Mr. F. W. Green, of Cambridge, a good archæologist, has often served as a volunteer. In 1898 Captain Lyons took over the charge of the whole of the survey departments of Egypt, while continuing his direction of the geological work.

It is not possible here to enumerate all the advances made in our knowledge through the labours of the little staff of geological surveyors in Egypt, but especial mention may be made of the important palæontological discoveries of Mr. Beadnell, aided by Dr. Andrews, in the Fayum, which included the finding of the wonderful Arsinotherium, and the ancestral forms of elephants and whales. Scarcely less interesting and important are the results obtained by Dr. Hume in his surveys of the Sinaitic peninsula, and of the eastern and south-eastern deserts of Egypt; and by Dr. Bell in his work around several of the oases and cataracts.

The results of all these researches are incorporated in the new geological maps of Egypt now issued. In spite of the existence of considerable blanks, these maps are a very great advance on any that have hitherto appeared. The oldest fossiliferous formation recognised is the Carboniferous, but considerable areas have to be mapped as "Nubian sandstones," portions of which may be of different geological age; there are also beds of gypsum, the position of which in the geological series is in some cases still doubtful. The Cretaceous strata are divided into Cenomanian, Senonian, and Danian, while the extensively developed Eocene strata have been distributed in three local divisions. Strata referred to the Miocene and Pliocene also occur, while Pleistocene and more recent deposits obscure wide areas. The larger-scale map forms six sheets, and the smaller a single sheet; all these are admirably printed in colour, and corresponding maps with hill-shading have also been issued by the Survey Department.

The survey staff has lost its original director, Captain Lyons, and also Mr. Beadnell, but it has been reinforced by the appointment of Mr. H. T. Ferrar, the geologist of Captain Scott's first Antarctic expedition; there have also been several other geologists who have served temporarily on the staff. The work is carried on at the present time under the directorship of Dr. W. Fraser Hume, who has had such a wide experience in desert-work, and is responsible for the maps which form the subject of the present notice. We are glad to learn from the last issued report of the survey that Dr. Hume proposes to write a general sketch of the "Geology of Egypt," this work, from such capable hands, will be looked forward to by geologists with much interest.

J. W. J.

THE BEGINNINGS OF BOTANY.

Landmarks of Botanical History. A Study in Certain Epochs in the Development of the Science of Botany. Part i., Prior to 1562 A.D. By E. L. Greene. Pp. 329. (City of Washington : Smithsonian Institution, 1909; Smithsonian Miscellaneous Collection, part of vol. xliv.)

DR. GREENE has contributed to the history of the progress of botany a work that bears evidence of unwearied research into the labours of

botanists whose influence on the science is realised by few, and whom it is well to remember with respect and gratitude. The book is wholly devoted to the early beginnings of the knowledge of plants, and to the revival of their study in the fifteenth and sixteenth centuries. It is not a work to be taken up to pass a leisure half hour. One feels disposed at times to question the author's presentation of his subject, but when the book has been read through one feels that it has well repaid the effort in the suggestive lights it has thrown on the past, on problems that are still with us, as well as on others that are no longer problems because solved for us by those early botanists. The treatment of the subject makes this book a valuable complement to the well-known "History of Botany" by Prof. Sachs, and there is much additional information in it.

Dr. Greene frequently is drawn into philosophical discussions in the definitions of his subjects. He defines the science of botany for the present work as occupied with the contemplation of plant as related to plant, and with the whole vegetable kingdom as viewed philosophically—not economically or commercially—in its relation to the mineral on one hand and to the animal on the other. From this point of view he recognises the beginnings of the science in the study of plants as plants, apart from their real or supposed economic worth. He finds true botanical science in the natural groups of popular language, and even in such terms as "herbs," "trees," and "grass," and still more clearly in such as "clover," "oak," &c. The correlation in value or kind of these and the like with the "genera" of systematic classification is insisted on. He concludes his introduction with impressing the view that "the essence and substance of botany proper are organography and the logical deductions we may draw from organography. The line of development of organography—as including terminology—is that along which a truly coherent and philosophic account of botany must be written."

A brief chapter is devoted to the Rhizotomi, whose maxims—so readily condemned as superstitions—he gives reasons to regard as in many cases judicious and well-founded.

By far the greater part of the book is occupied with brief biographies and detailed consideration of the work of five writers: Theophrastus of Eresus, Otto Brunfels, Leonhard Fuchs, Hieronymus Bock (Tragus), and Valerius Cordus. Short chapters on Greek and Roman writers after Theophrastus, on the early German writers, and on Euricius Cordus, father of Valerius, complete the volume.

Few botanists can claim to have gained a knowledge from his own writings of the part filled by Theophrastus in the progress of botany. To most Dr. Greene's estimate of his work will prove a revelation of a very surprising kind. The minute and careful analysis of the information contained in the two books that have survived, in an unfortunately imperfect state, shows that he was a genius and investigator far in advance of other botanists of his time. A recapitulation is given at the close of the chapter indicating seventeen heads regarded as "elements of universal botany of which Theophrastus appears to have been the discoverer and first promulgator." While it may be felt in regard to some of these that Dr. Greene is disposed to press the point unduly, the larger part are of such importance as to justify the claim to a front rank among botanists, and to show the inadequacy of the judgment expressed on him in Sachs' book.

Brief notices of Dioscorides, Varro, Virgil, Pliny, Galen, and others, bring out the contrast of these with Theophrastus, their inspiration being chiefly the study of plants for their useful or harmful properties, though they also added at times to the knowledge of plants as plants. During the long period of more than twelve centuries after the time of Galen, the natural sciences, instead of advancing, fell much into decay, and were in part represented by such works as the "Ortus Sanitatis," filled with grotesque figures and strange perversions of the truth.

The reawakening from this condition is placed by German historians of the science, such as Meyer and Sachs, in the sixteenth century, when the "Herbarum Vivæ Iceones," of Otto Brunfels, was issued, and was succeeded by, among others, the works of Fuchs, Tragus, and Valerius Cordus. Brunfels and Fuchs, he points out, busied themselves almost wholly with plants as medicinally valuable; and their books are little more than compilations illustrated by figures of the plants to which they believed their borrowed descriptions referred. These figures were excellent in comparison with those in use previous to Brunfels; but in other respects neither Brunfels nor Fuchs can be shown to have made any important step forward. Fuchs introduced his "Historia Stirpium" with "An Explanation of Difficult Terms," from which his views on the structure of plants can be gathered, and are found in general to be retrograde from those expressed by Theophrastus.

Bock or Tragus (1498–1554) had a different point of view from Brunfels and Fuchs, and may deservedly be accepted as having opened the new era of botany. He studied plants for their own sakes; and, possibly in part from inability through poverty to employ illustrations in his "New Krauterbuch," he sought to describe them so clearly as to make it possible for others to recognise them from the descriptions alone. He wrote his books in German instead of the customary mediæval Latin; a translation into Latin being afterwards issued for use in other countries. He merely names the common and well-known plants, describing the scarcer and previously unknown forms. His method required, and was based on, very careful personal investigation; and he thus was able and was led to make important contributions to the science in various directions. Dr. Greene discusses Tragus's views on classification, nomenclature, ecology, &c., very suggestively and justly, with full recognition of his great merits but also calling attention to errors.

Euricius Cordus is given a place of honour for his sole botanical work, in which he points to defects in the study of botany in his day, but still more as the father and teacher of Valerius Cordus. The latter died at the age of twenty-nine, while travelling in Italy, but had won reputation by a work on the preparation of medicines published during his lifetime.

He had travelled extensively in remote parts of Germany, had discovered many more plants than had been made known since the revival of botanical study in Germany, and had described these carefully in a work, "Historia Plantarum," left in manuscript. This was published some years after his death, edited by Conrad Gasner, who, by desire of the publisher, employed illustrations (prepared to accompany Tragus's work) to illustrate the descriptions of Cordus, to which they were occasionally incorrectly fitted. From a careful study of the descriptions, Dr. Greene shows cause to regard Valerius Cordus as of rare ability and insight, and esteems him to have been immeasurably the greatest of the "German fathers of botany." Among the services to botany ascribed to him we are told that "he is the inventor of the art of phytography"; that in all descriptions "attention is given to the morphology and life-history of the plant in as far as is known to him"; that new terms are employed expressing new ideas and points of view in the science, and that new conceptions appear in regard to inflorescences, flowers, fruits, and seeds. In taxonomy he shows clearer views with regard to species, and his groups were more often based on relationships than were those of his predecessors. A number of his groups of generic rank stand good, though in most cases the names given by him were needlessly changed by Linnæus. He paid heed to internal structure (so far as that could be determined by him, that is, by the unaided eye), and to physiology, as regards prefloration, modes of climbing, and similar features of plant-life. He also gave attention to the varieties of cultivated fruits, of which excellent descriptions are extant by him. What he succeeded in doing suffices to show how grievous a loss botany sustained in his early death.

VECTOR ANALYSIS.

Éléments de Calcul vectoriel, avec de nombreuses Applications à la Géométrie, à la Mécanique, et à la Physique mathématique. By Prof. C. Burali-Forti and Prof. R. Marcolongo. Édition française traduite de l'Italien et augmentée d'un Supplément par S. Lattès. Pp. vi+229. (Paris: A. Hermann et Fils, 1910.) Price 8 francs.

THE variety of matter contained in this small book shows the condensing power of vector notation, especially when combined with a concise literary style. The theoretical part includes the elements of the barycentric calculus, as well as a vector analysis in which vectors are written either in single letters, or in the form B–A, where A, B are points. Scalar and vector products are treated separately, so that quaternions do not come in. Special points to notice are that a scalar product has given to it the sign opposite to that assigned by Hamilton; the effect of this is that if α, β, γ are three orthogonal unit-vectors, $\alpha^2=\beta^2=\gamma^2=1$, and versors have to be treated by introducing a symbol i, such that $i^2=-1$, and is *not* a vector. There is a good deal to be said for this; but it is most unfortunate that the authors take the clockwise sense of rotation for the positive one, especially considering the use of vectors and vector products in physics.

The applications include geometrical, mechanical, hydrodynamical and electrical formulæ. Specially to be noted are the proofs of Green's theorem and its congeners, Stokes's theorem of circulation, and Hertz's formula for variation of flux.

There is an appendix, partly historical, partly critical and even polemic. Probably every reader will find something here with which he cordially disagrees; but there is one statement that deserves special attention. We believe that the authors are right in thinking that the final notation of the vector calculus will be based on Grassmann's "Ausdehnungslehre," as improved and modified by subsequent writers. The Hamiltonians will have nothing more than a sentimental grievance if this proves to be the case. Nothing can upset, or even modify, the quaternion calculus, because it is a definite type of linear algebra; the main question now is whether *this* algebra is the best for the treatment of physical, and especially electrical, problems. Judging by the attitude of Gibbs, Heaviside, and Lorenz (to name only these), the answer appears to be no.

There is very little fear that a really convenient notation will not be ultimately agreed upon; it will probably be invented by a physicist. Meanwhile, dispassionate observers will derive some amusement, as well as much instruction, from the lively controversies of the champions of this or that particular symbol, as if its retention or rejection were of vital importance in itself. For instance, our authors seriously object to a symbol such as $[\alpha\beta]$ for a scalar product, on the ground that functional symbols are invariably placed on one side of the operand! The example of $\int ydx$, where $\int()dx$ is practically a functional symbol, shows that the statement is barely true, except in an artificial sense; but even if it were strictly true, this would be no reason for regarding it as a necessary law of mathematical notation. G. B. M.

MAP-MAKING.

The Theory of Map-Projections, with special reference to the Projections used in the Survey Department. By J. I. Craig. Pp. iv+80. (Cairo: National Printing Department, 1910; Ministry of Finance, Egypt Survey Department.) Price 200 milliemes.

THE subject of map projections is one in which the English language is strangely deficient, a deficiency the more apparent when contrasted with the wealth of Continental literature on the subject. Those interested in the higher theory of map-making will, therefore, welcome the appearance of this little treatise, which seems to give in a compact and practical shape all the essentials of this attractive branch of the geometry of surfaces. Starting with a statement of the problem to be solved, and an allusion to possible improvements in nomenclature; the term projection itself, in the meaning of a representation in accordance with any law, for instance, is not a particularly happy one; a history is given of the adop-